INFORMATION TECHNOLOGY OFFICE

Global Mobile Information Systems

(GloMo)

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Information Technology Office
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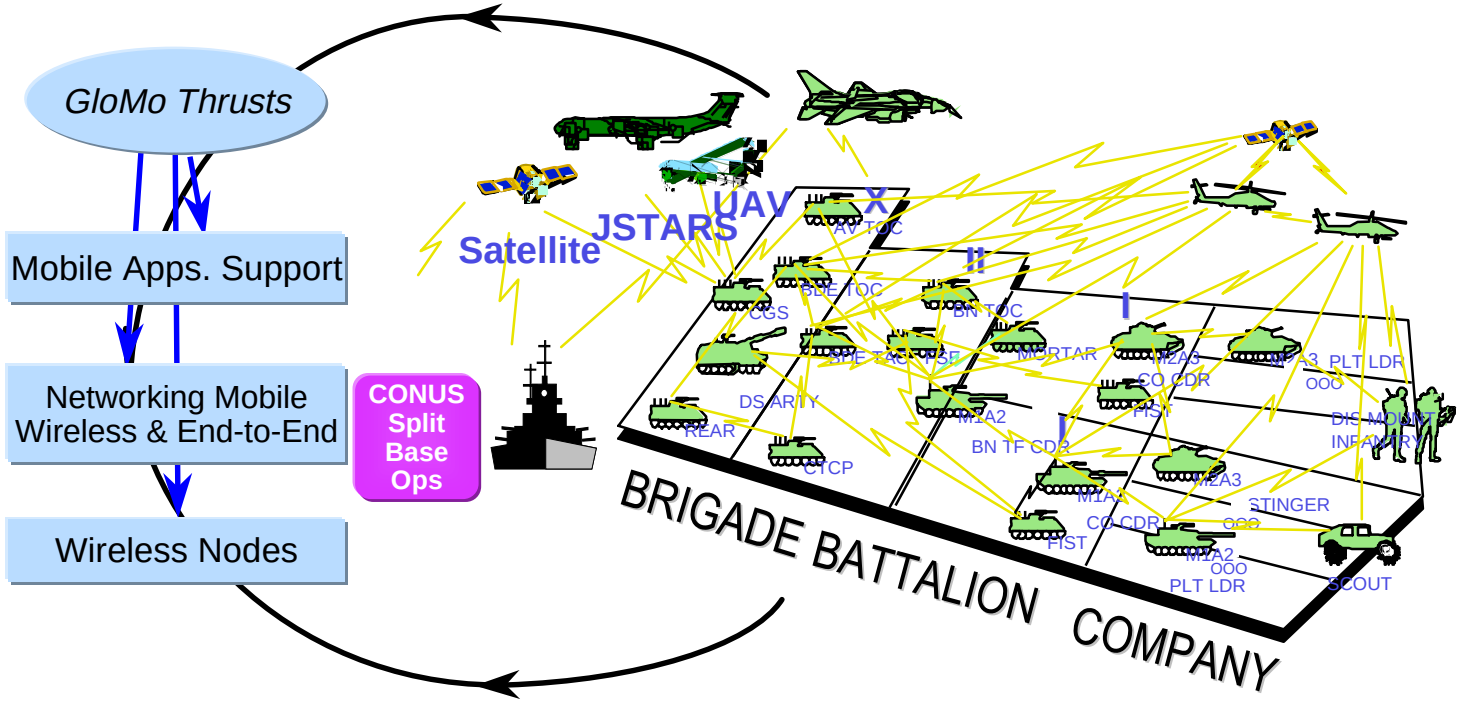
Global Mobile Information Systems (GloMo)

Make the mobile environment a first-class citizen in the Defense Information Infrastructure



Defense Wireless Environment

- No pre-deployed infrastructure or fixed base stations
- Environment is subject to significant changes (weather, terrain, foliage, EMI)
- Mobile operations
- Significant variation in link quality and sporadic connectivity

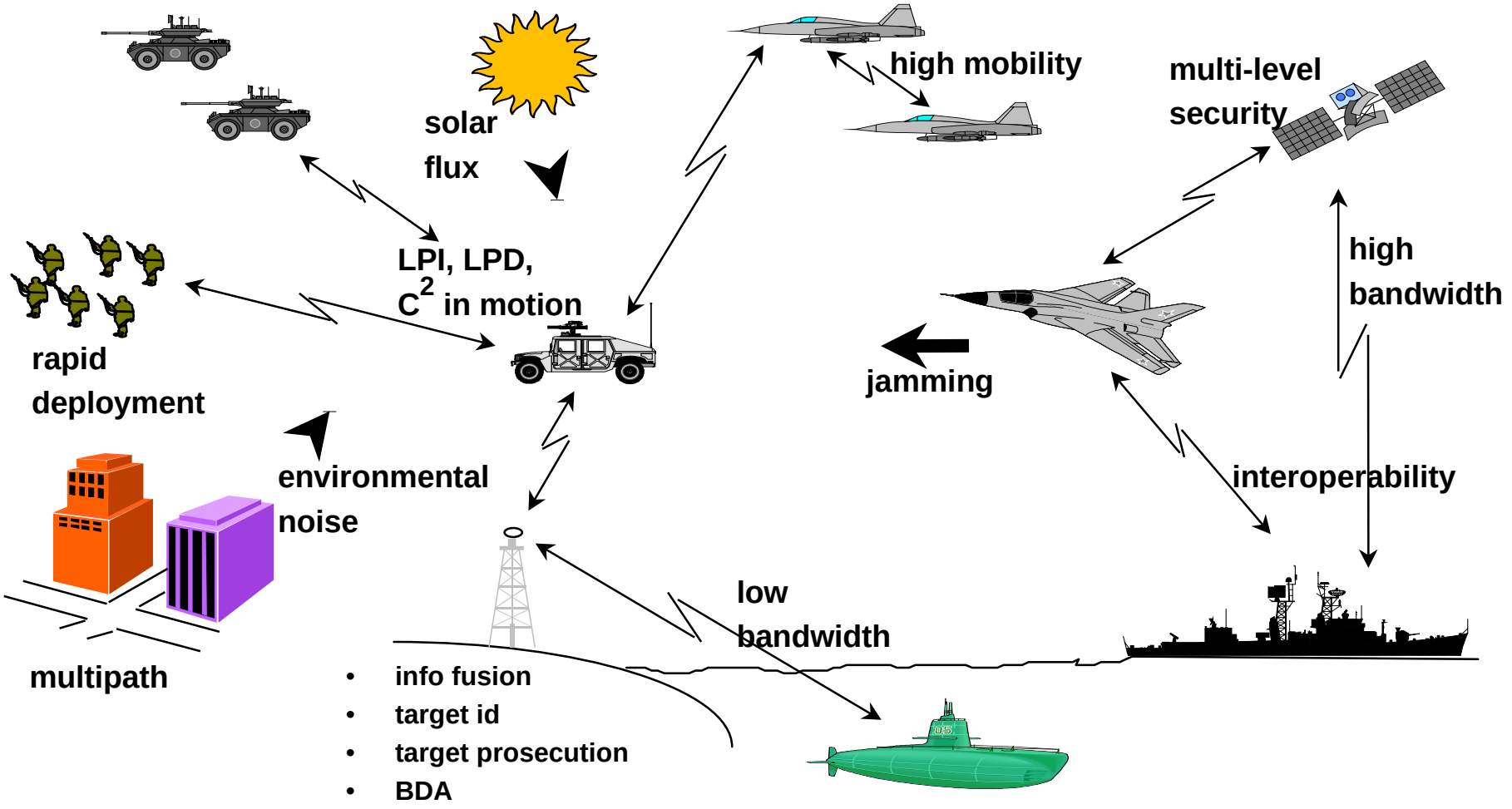
Services for Mobile Wireless Users

- E-mail
- Voice
- Image & Video Transmission
- File Transfers
- Web Browsing
- Video Conferencing
- Collaborative Planning
- Multimedia
- Broadcast Services

Secure Mode

Challenge: Dynamic interaction between radio, networking, and application support layers

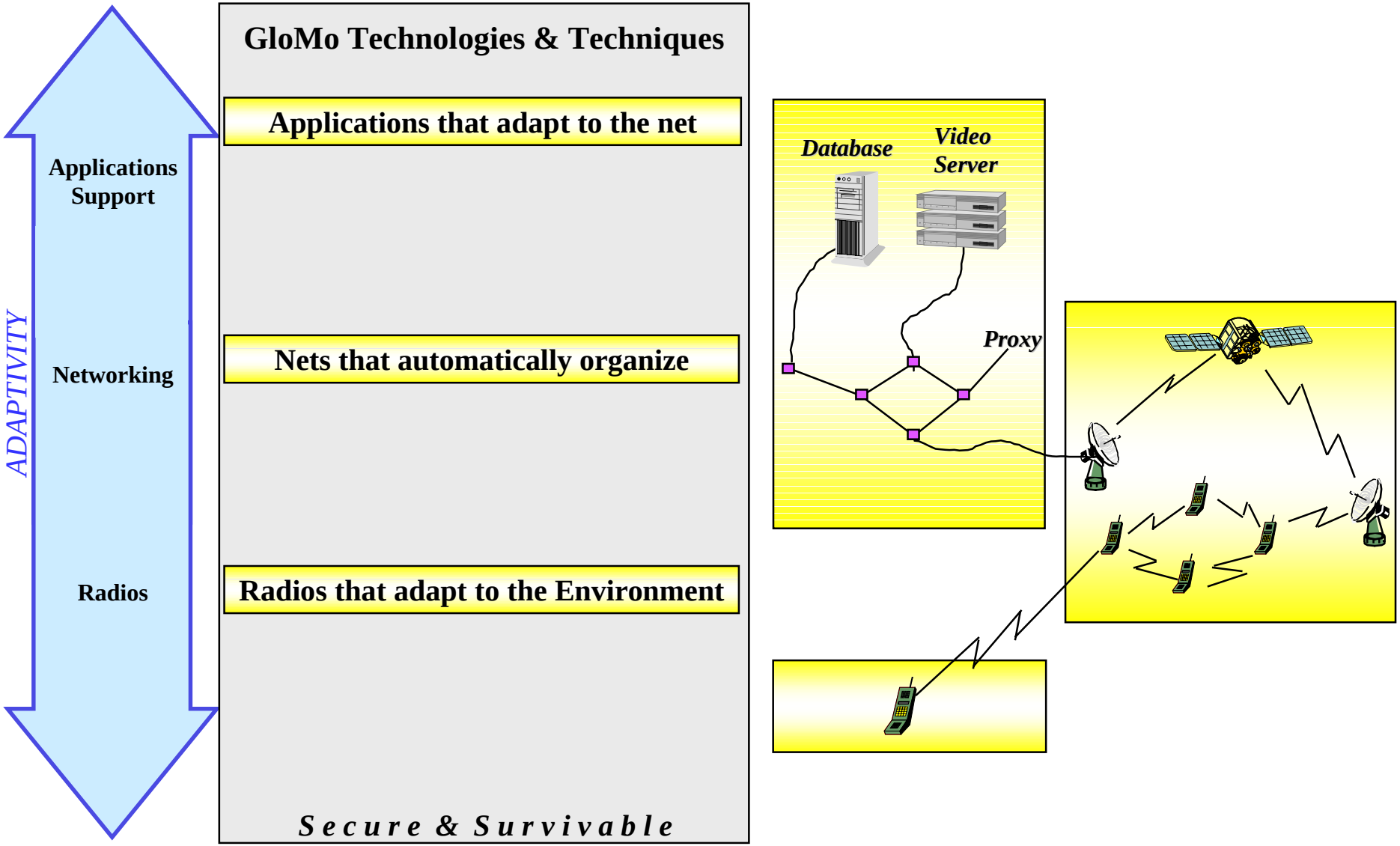
Road Rage ≠ Shell Shock



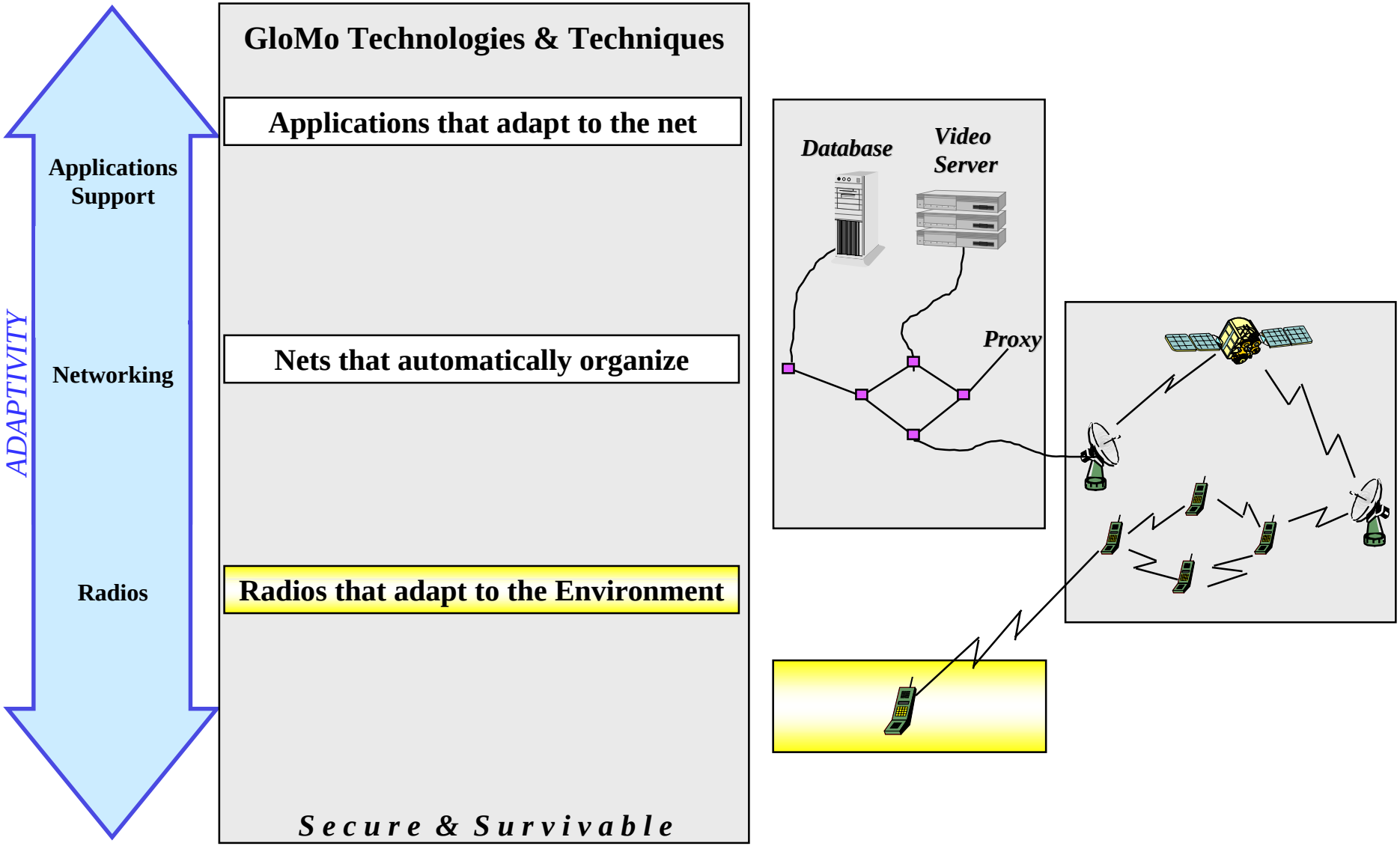
Commercial vs. Mission Operations

Commercial	***Mission Ops***
Fixed, pre-located cell sites	**Rapid deployment, constrained access, opportunistic**
Static network topology	**Highly dynamic topologies with multi-hop, sporadic connectivity**
Static allocation; narrow-band channels	**Dynamic bandwidth allocations, priority, high bandwidth imagery**
Maximize number of users/ hertz in a given area	**Hertz/user as needed in hostile environment**
Privacy	**Security**

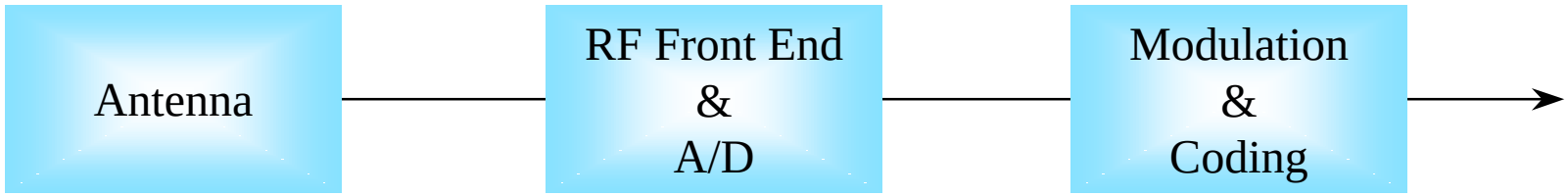
Focus Areas


ADAPTIVITY
Applications Support
Networking
Radios
GloMo Technologies & Techniques
Applications that adapt to the net
Nets that automatically organize
Radios that adapt to the Environment
Secure & Survivable
Database
Video Server
Proxy

Focus on Radios



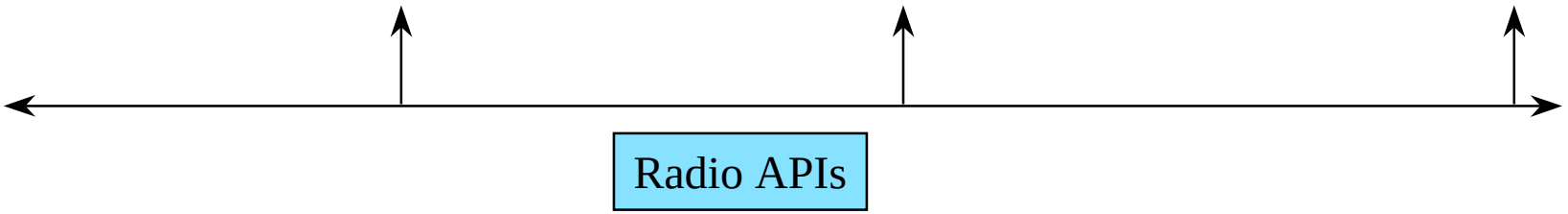
Radios that Adapt to Applications and Environment



- Range Extension
- High Data Rates
- Interference Rejection
- Adapts for Orientation

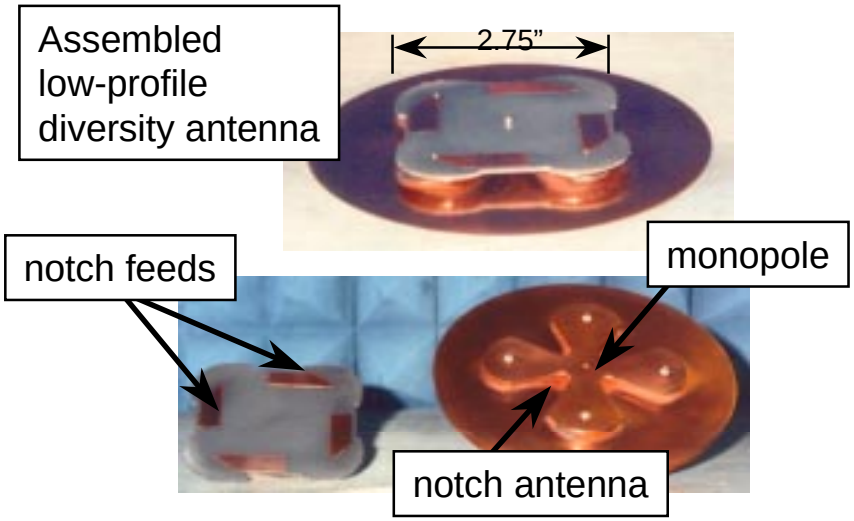
- Low Power
- Small Size
- Frequency Agility/Flexibility

- Low Power
- Adaptive Coding
- Multipath/Doppler



Reconfigurable Antennas for High-Data Rate Untethered Nodes

Radios
- Smart Antennas
- Agile RF Front End
- Adaptive Coding



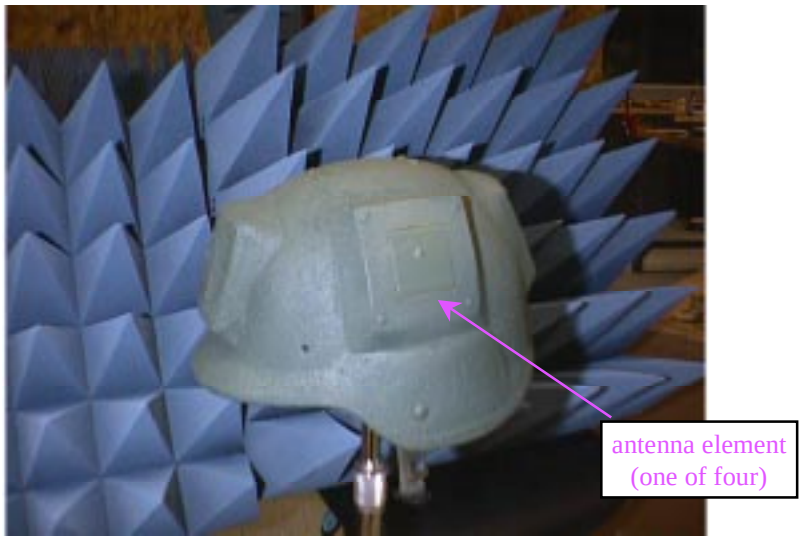
Objective

- Develop compact, rapidly reconfigurable smart antennas for handheld, soldier-mounted, and vehicle-mounted radio systems
  - improved immunity to multipath fading
  - minimal gain reduction due to re-orientation
- Enable multi-hop network architectures with untethered nodes moving at vehicular speeds

Accomplishments

- Helmet antenna system Feb 98
  - covers 2.4 - 2.5 GHz ISM band
  - single-polarization 4-beam system
  - >20dB gain improvement over worst-case scenario
- Dual-polarization 4-beam system planned July 98

Helmet-mounted Diversity Antenna



Wideband RF Front End

Radios
- Smart Antennas
- Agile RF Front End
- Adaptive Coding

Objective

- Design and build miniature radio codec
  - 20 - 3000 MHz
  - .01 - 10MHz Bandwidth

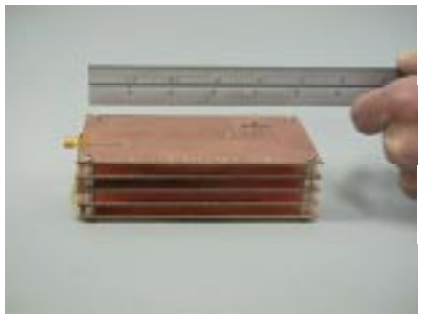
Accomplishments

- Demonstrated broadband direct sequence transceivers 20 - 2000 MHz with continuous transmit & receive

28 Watts
500 µs tuning
366 cu inches

October 97

18 cu inches
5 Watts



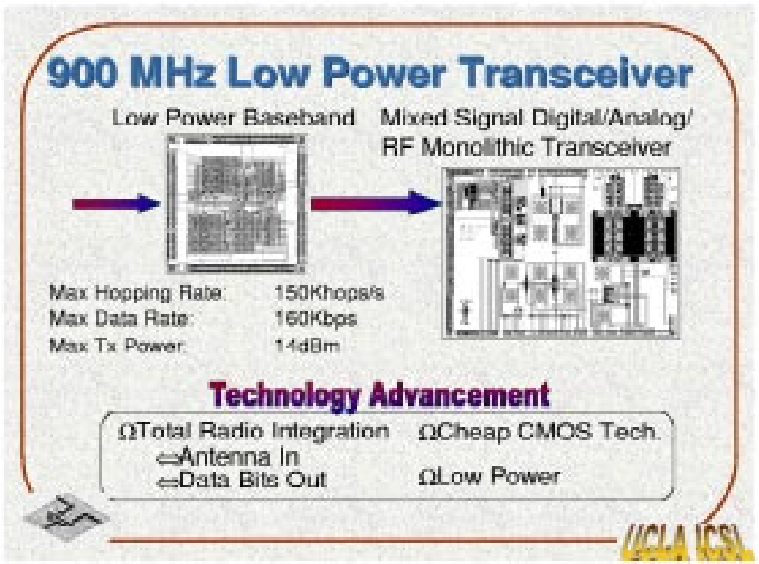
September 98

5 cu inches
1-4 Watts
100 µs tuning

June 00

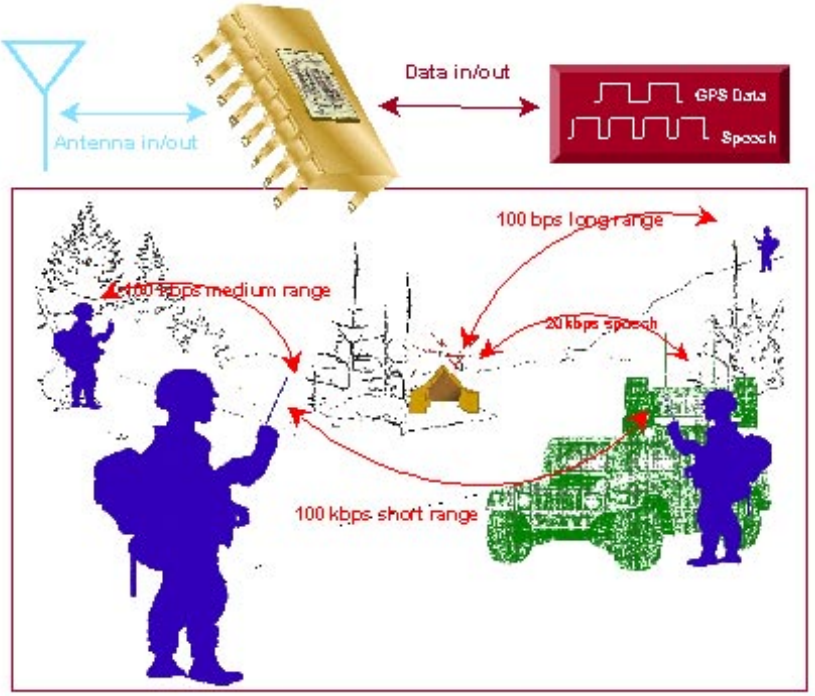
Low Power Radios for the Individual Soldier

Radios
- Smart Antennas
- Agile RF Front End
- Adaptive Coding



Objective

- Miniaturized Transceiver
- Low Power , 50 mW
- Variable data and hopping
  - 128 bps to 128Kbps
  - hopping rates to 200,000 hops/sec



Power Reduction Techniques
(order of magnitude reduction)

- Integrated receiver architecture
- Use high quality off-chip inductors
- Closed-loop techniques to compensate for the loss of linearity in open-loop CMOS circuits

Focus on Networking

ADAPTIVITY

Applications Support

Networking

Radios

GloMo Technologies & Techniques

Applications that adapt to the net

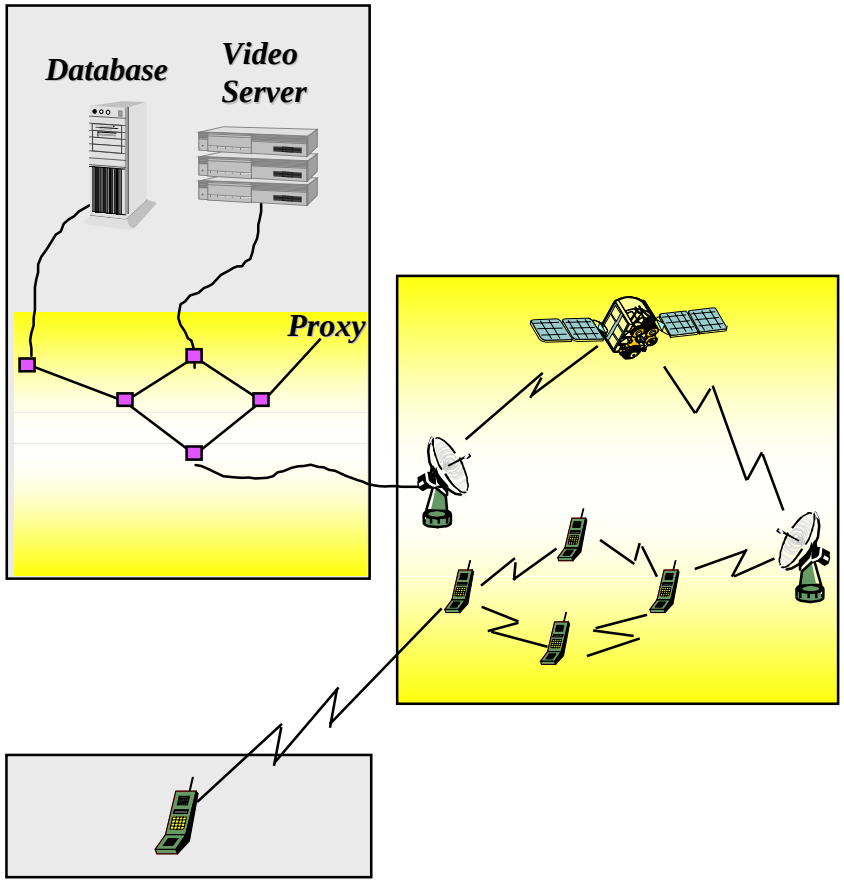
Nets that automatically organize

- Self organizing, multihop
- Vertical Handoffs
- Geo-routing
- Secure/Survivable

Radios that adapt to the Environment

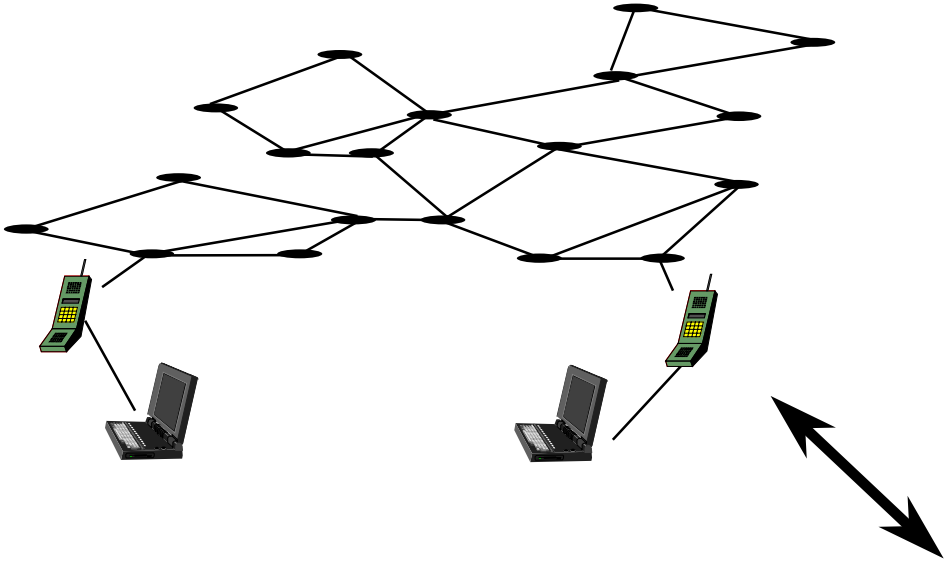
- Smart Antennas
- Agile RF Front End
- Adaptive Coding

Secure & Survivable



Adhoc Networking

Nets that automatically organize
- Self organizing, multihop
- Vertical Handoffs
- Geo-routing
- Secure/Survivable

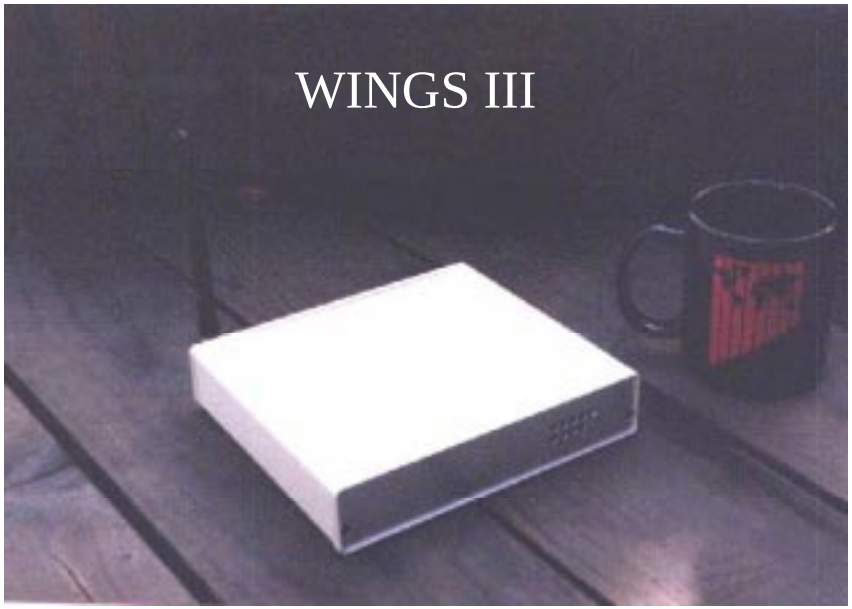


WINGS Protocols

Wireless Internet Gateways (WINGs)
- fully functional IP routers
- support rapidly-deployed, self-managing network

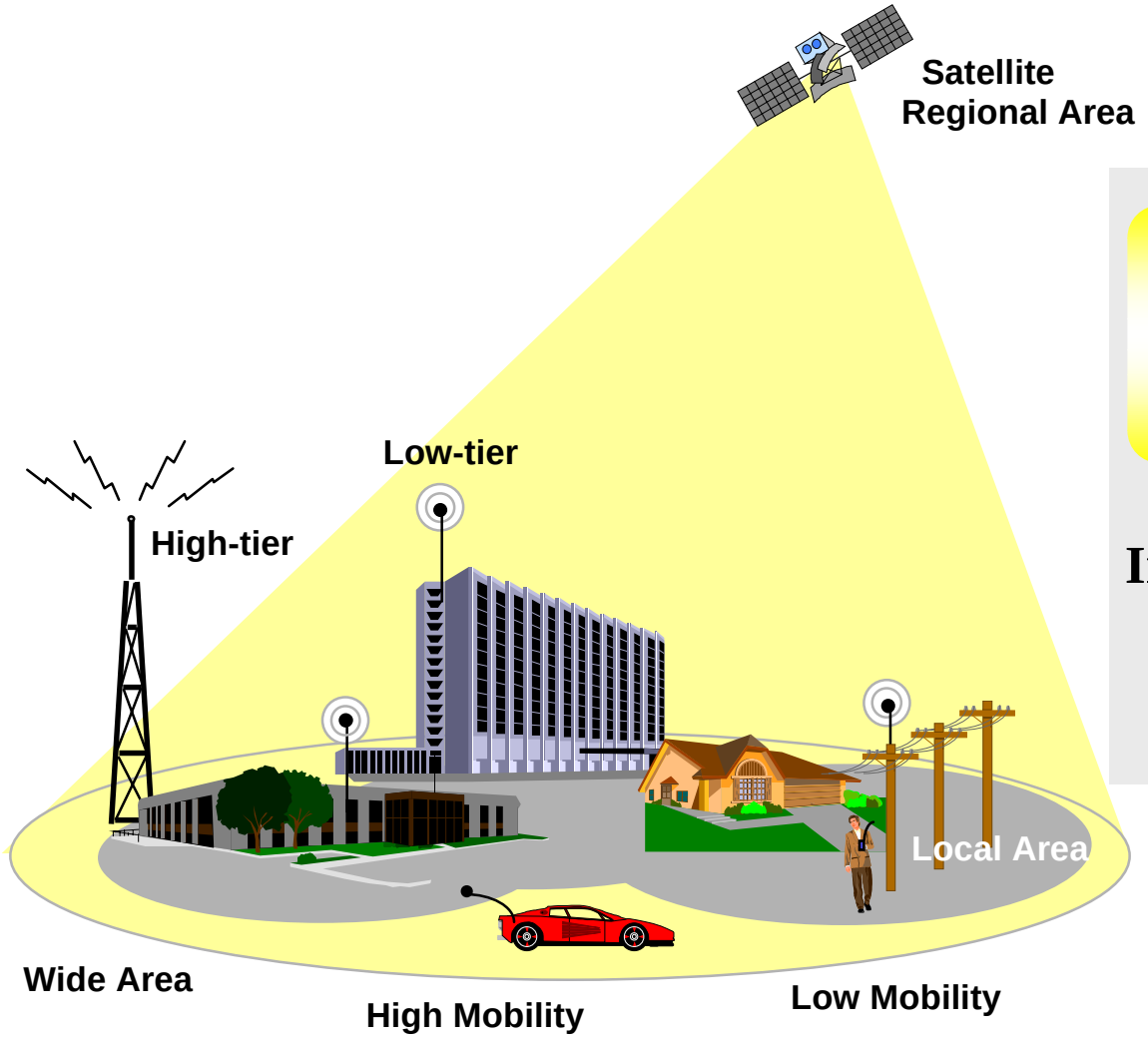
Impact

- **Dramatic improvements in ad-hoc mobile networking protocols**
  - Fast, low-overhead Routing Protocols
  - Loop-free multicast protocol
  - Overcomes hidden node problem
- **Radio API developed and used in SUO, ACN, & WRN**



Overlay Internetworking

Nets that automatically organize
- Self organizing, multihop
- Vertical Handoffs
- Geo-routing
- Secure/Survivable



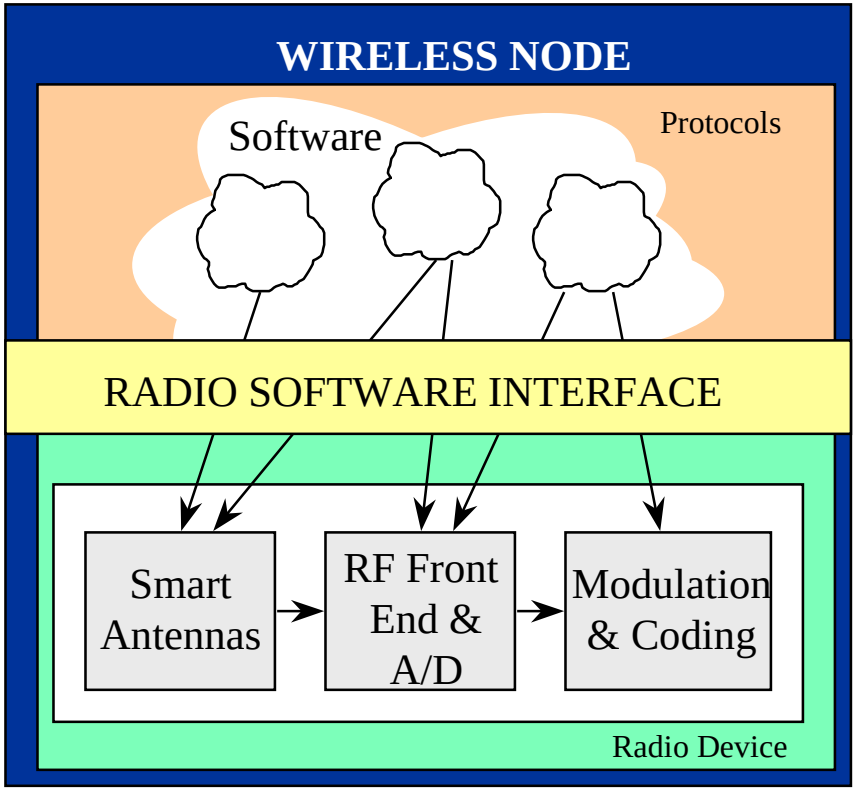
New Ideas

- **Vertical Handoffs**
  - "Overlay" IP Extensions to Mobile IP
  - Low Latency Inter-subnet Handoffs
  - High Throughput Reliable Transport

Impact

⇨ Seamless roaming across 3-4 orders of magnitude of b/w and latency (10kbps to 10mbps, 1 ms to 1s)

Radio Device Software Interfaces



- Common "APIs" for ***rapid & effective integration*** of new protocols and digital radios
- ***Forum for information exchange*** between protocol and radio developers
- ***Supports advanced GloMo radios*** (multichannel, adaptive waveforms) ***& COTS radios***
- Encourages ***open architecture*** (non - stove pipe) solutions

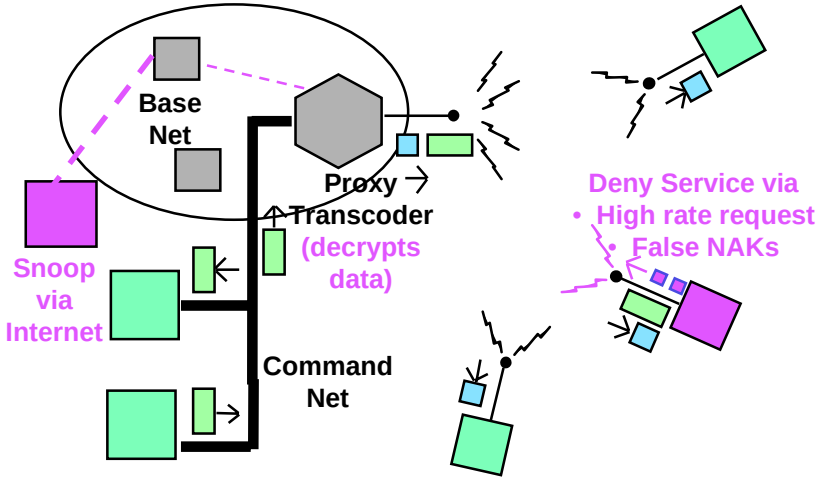
Acceptance/Implementation

- **WINGS I & II Prototypes**
- **CPT Simulator**
- **GUMPS**
- **ASPEN**
- **UTILICOM 2040**
- **SUO**
- **A C N**
- **CECOM WNR Testbed**

Information Survivability Technology & Experiments for GloMo

Nets that automatically organize
- Self organizing, multihop
- Vertical Handoffs
- Geo-routing
- Secure/Survivable

Attack Scenario against Multirate, Multicast Conferencing



Objective

- Identify vulnerabilities of global mobile information systems
- Develop technology that enhances survivability and security

Approach

- Integrated experiments in secure, survivable conferencing & collaborative planning

Accomplishments

- Acquired representative sample of reliable multicast protocols - RMP, RMTP, GSRM, SRM
- Developed attacks against RMP and SRM - disrupt multicast image transfer
- Secure, rate-adaptive video conferencing demonstrated using vic, vat, IPSEC, and Fortezza

Focus on Applications Support

ADAPTIVITY

Applications Support

Networking

Radios

GloMo Technologies & Techniques

Applications that adapt to the net

- Proxy Server
- Adaptive Middleware
- Opportunistic Delivery

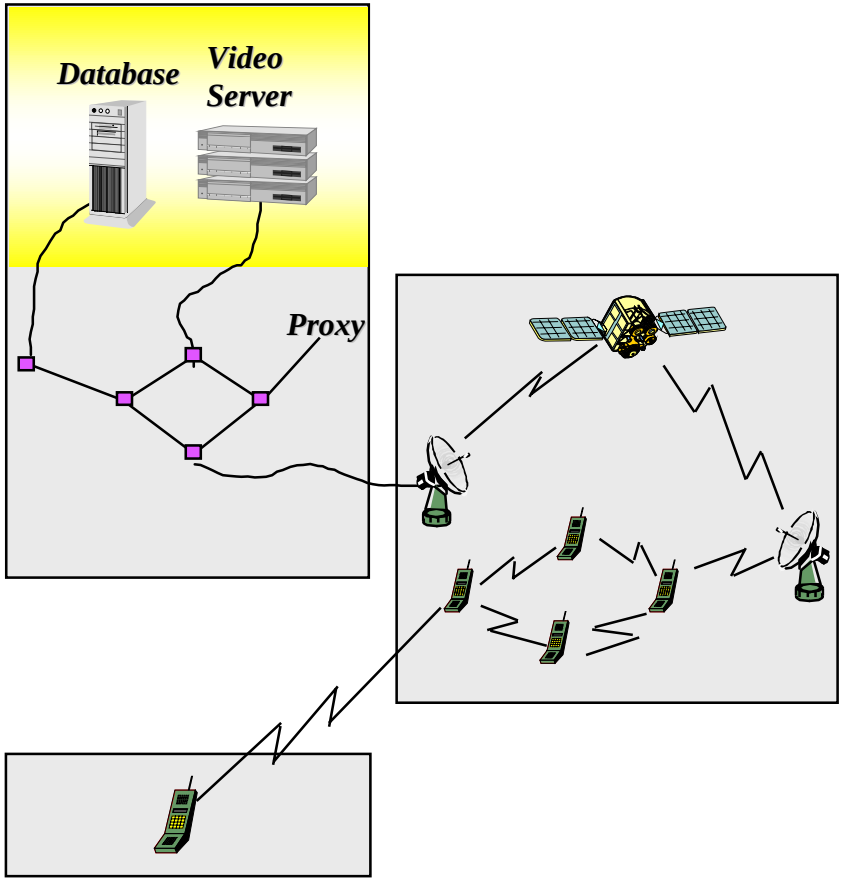
Nets that automatically organize

- Self organizing, Multihop
- Vertical Handoffs
- Geo-routing
- Secure/Survivable

Radios that adapt to the Environment

- Smart Antennas
- Agile RF Front End
- Adaptive Coding

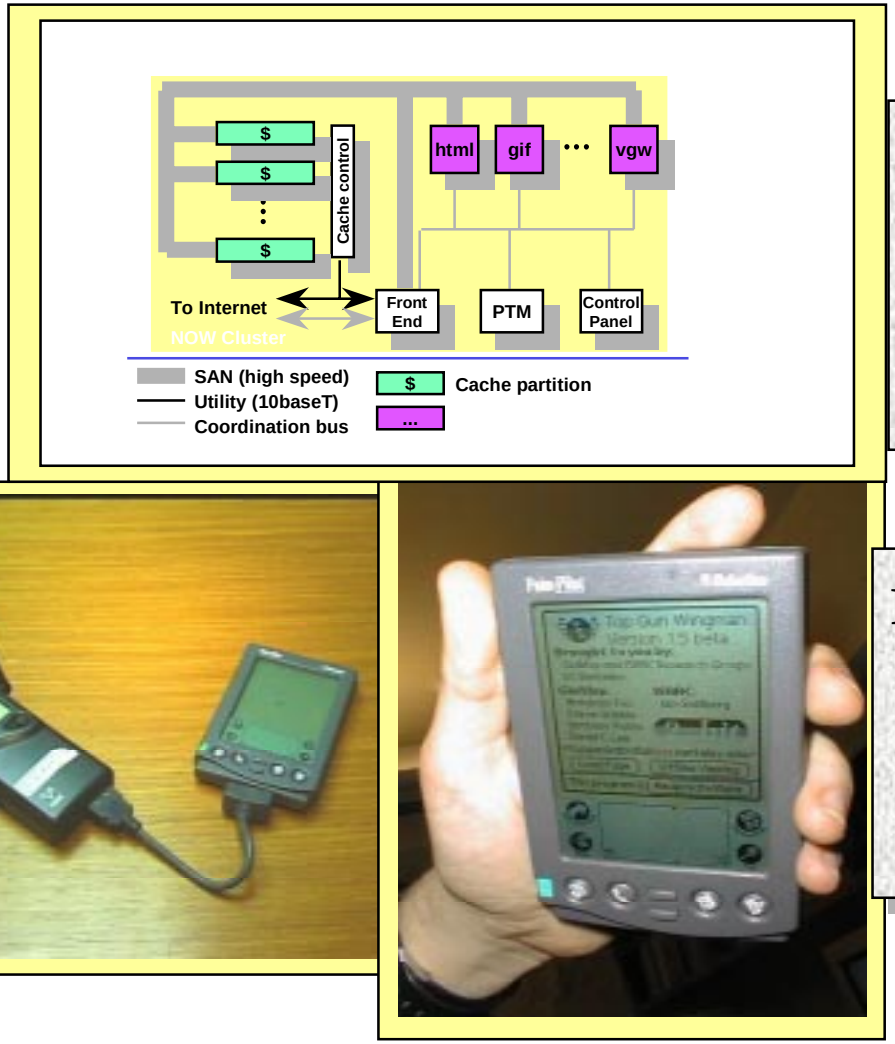
Secure & Survivable



Proxy Server Supports Low Bandwidth & Low Power Users

Applications that adapt to the net

- Proxy Server
- Adaptive Middleware
- Opportunistic Delivery



Campus Wide Implementation

- TRANSEND deployed July '97 campus wide at Berkeley
- Web Browsing supported for over 10,000 users

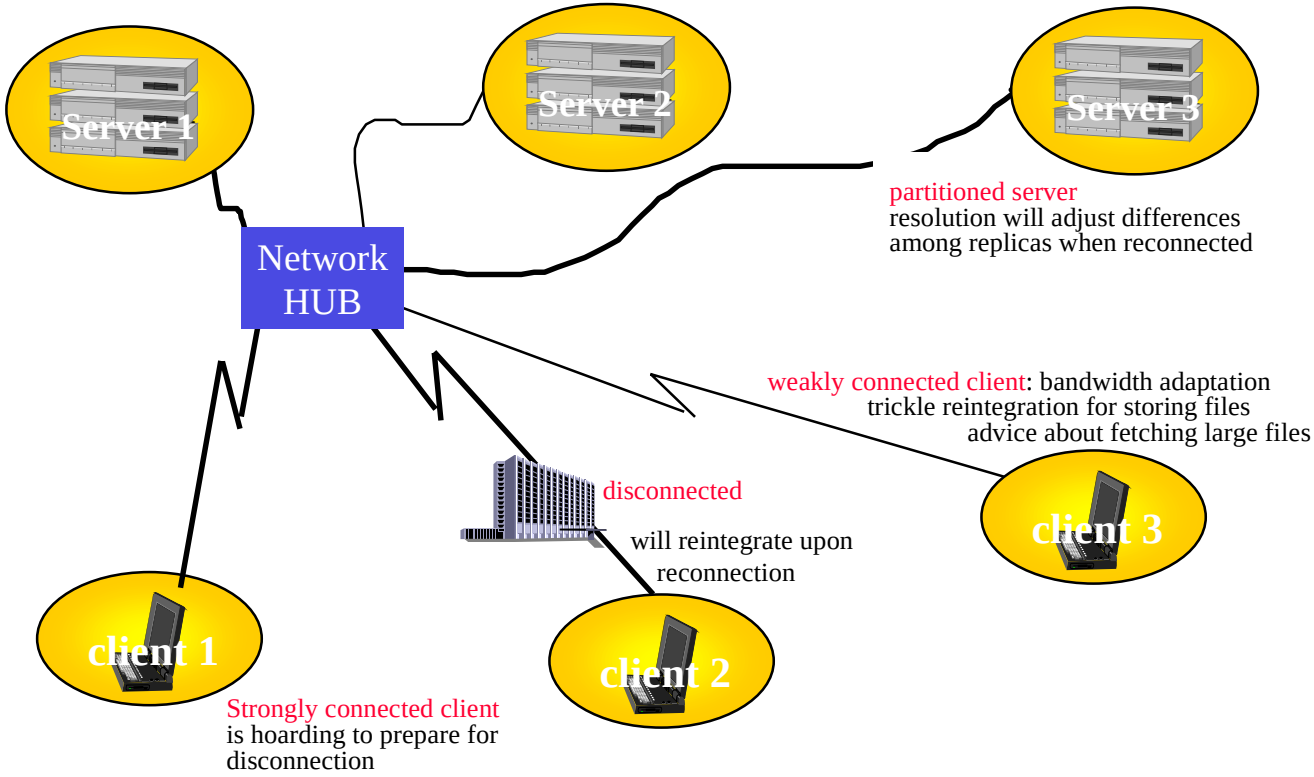
Proxy support for low Power PDAs

- Web Surfing
- Grey-Scale Imagery
- Electronic Maps
- Over 5000 copies of S/W distributed

Adaptive Middleware for Mobile Data Access

Applications that adapt to the net

- Proxy Server
- Adaptive Middleware
- Opportunistic Delivery



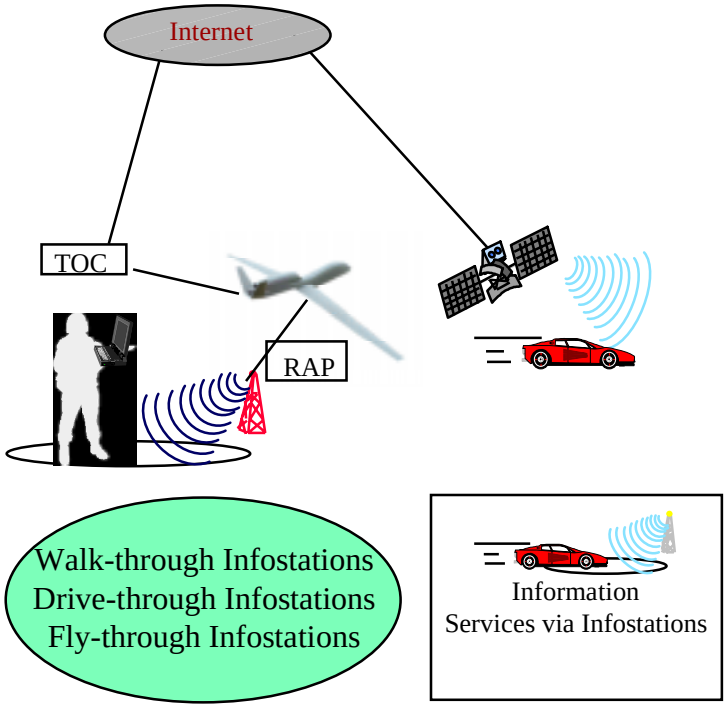
- **Mobile Computing:**
  - disconnected operation
  - weakly-connected operation
  - bandwidth adaptation

- **Failure Resilience:**
  - replicated servers
- **Performance:**
  - persistent client cache
- **Security:**
  - trusted servers, clients access-controlled

Opportunistic Data Delivery (NIMBLE)

Applications that adapt to the net

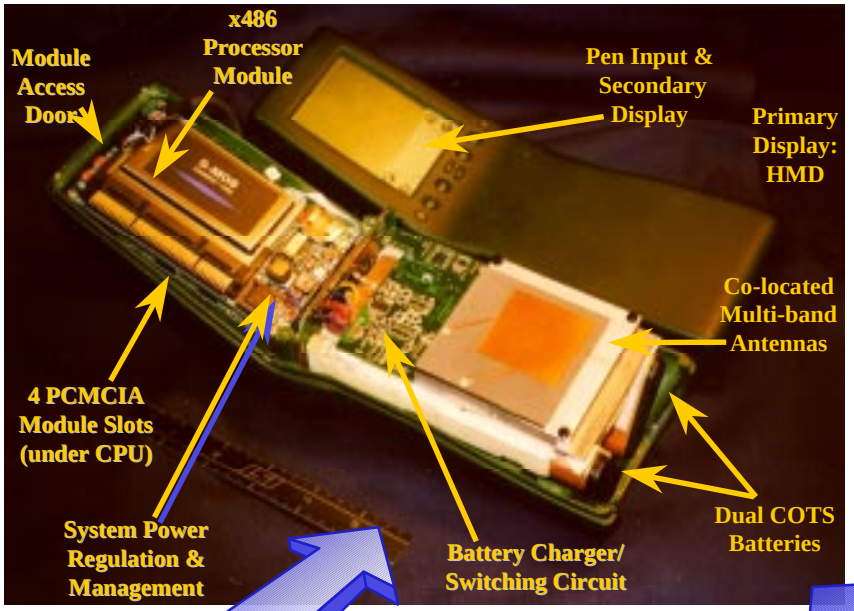
- Proxy Server
- Adaptive Middleware
- Opportunistic Delivery



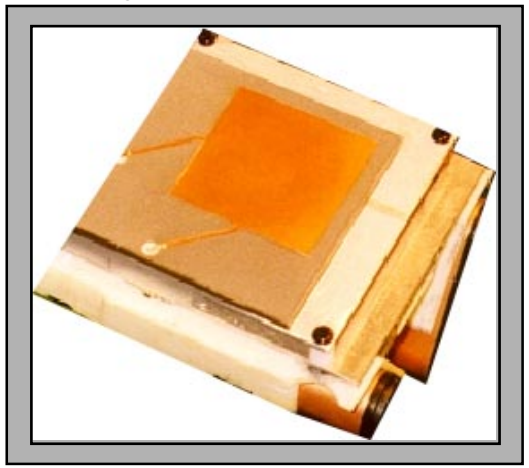
New Ideas

- **Infostations**
  - Wide-area Narrow-band coverage to request data
  - Spotty wide-band coverage for fast data transfer
  - Different types of Infostations
- **Low Latency Protocols**
  - Reservation protocols for Infostations
  - Adaptive protocols for low latency transfers
  - Routing, scheduling, transfer protocols
- **Applications**
  - Location-dependent information
  - Personalized information
  - Push and pull information

Integrating Commercial & GloMo Technologies



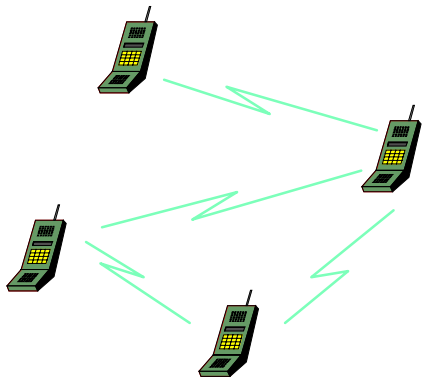
Electrically-Small Multiband Antennas



Objective

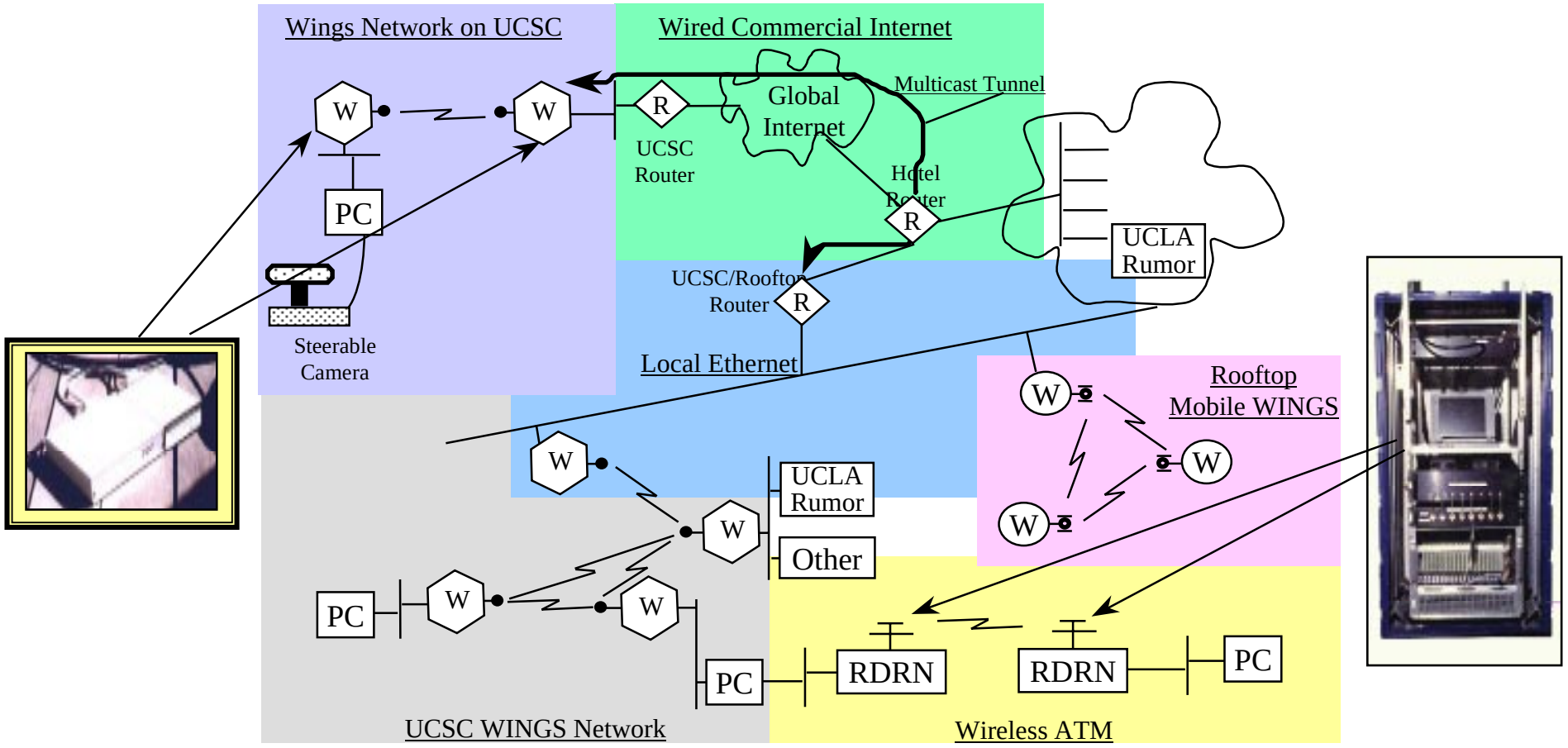
- Develop low cost approaches to implementing highly modular radios
  - enables rapid prototyping
  - insertion of new GloMo technologies
- Investigate data and control boundaries

WINGS

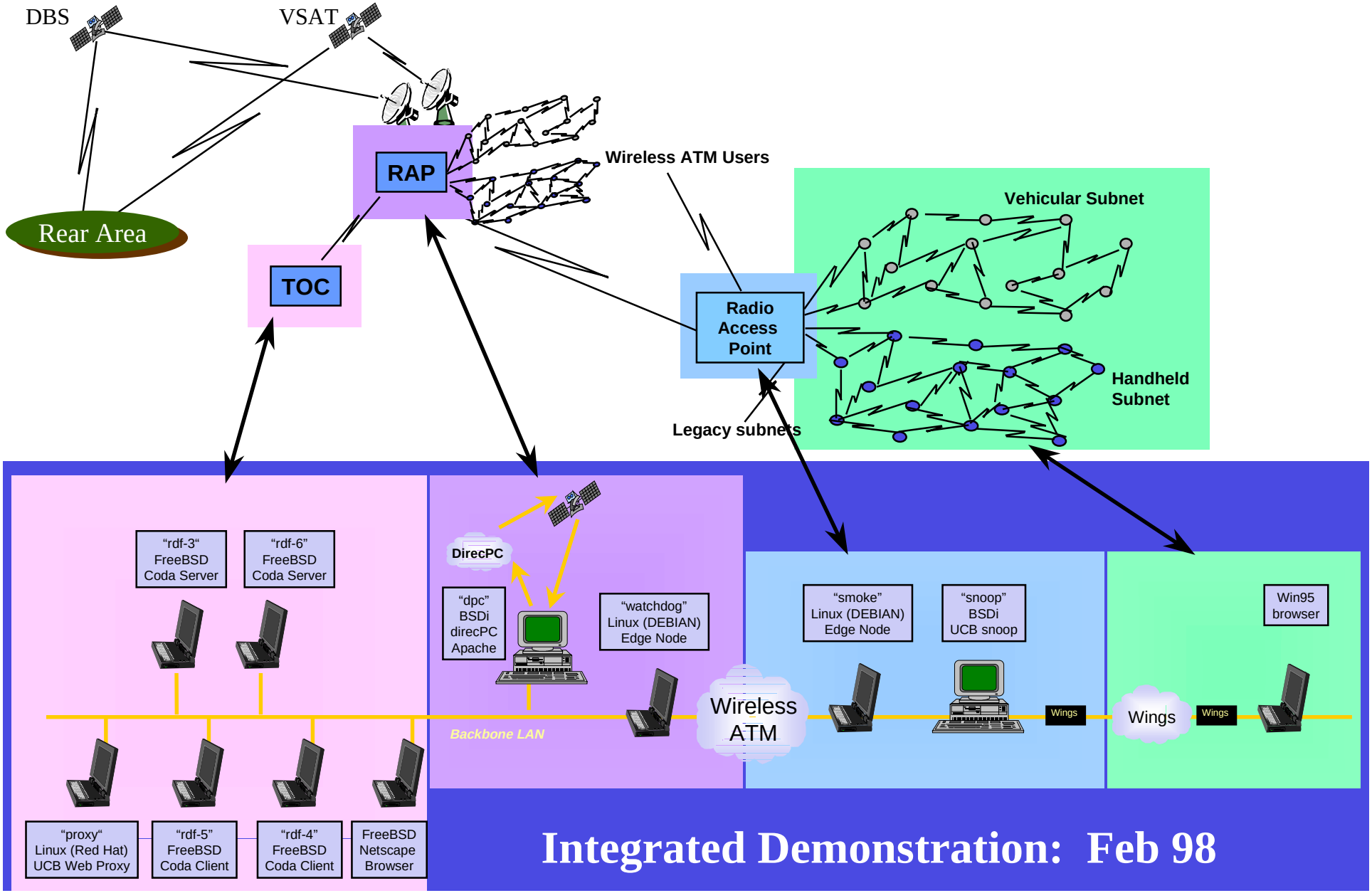


Rapidly-deployed, self-managing wireless multihop" network extensions to multimedia Internet

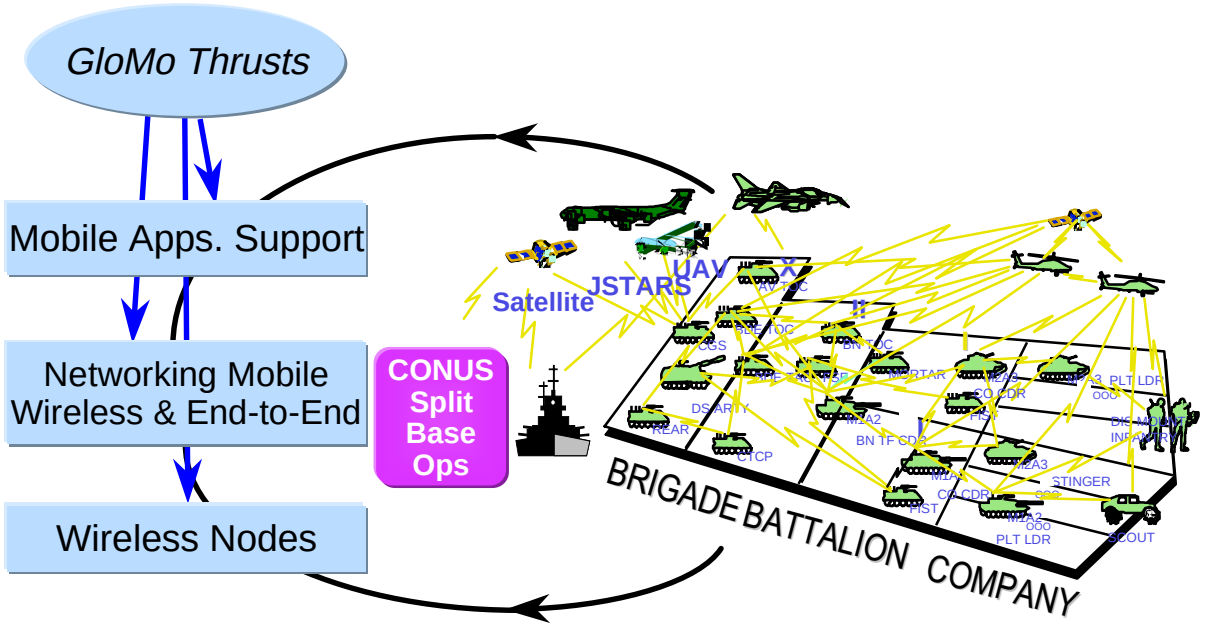
Integrated Feasibility Demonstration: July 97



Military Application-Oriented Demonstrations: July 98



Program Impact



Without Program	*With Program*	*Example Impact on MultiMedia Conferencing*
■ mobile voice-grade bandwidth	■ high rate data mobile bandwidth	■ video rather than still-frame
■ single hop support	■ multi-hop support	■ broad availability across deployment
■ deployment in days ■ vertically integrated applications	■ deployment in minutes/hours ■ common underlying application support	■ rapid availability of critical capability ■ interoperability with multiple applications
■ quasi-static QoS ■ static application	■ dynamic QoS ■ dynamic application adaptation	■ optimum quality at any time ■ flexible quality at every site
■ replicated data	■ survivable data	■ robust capability